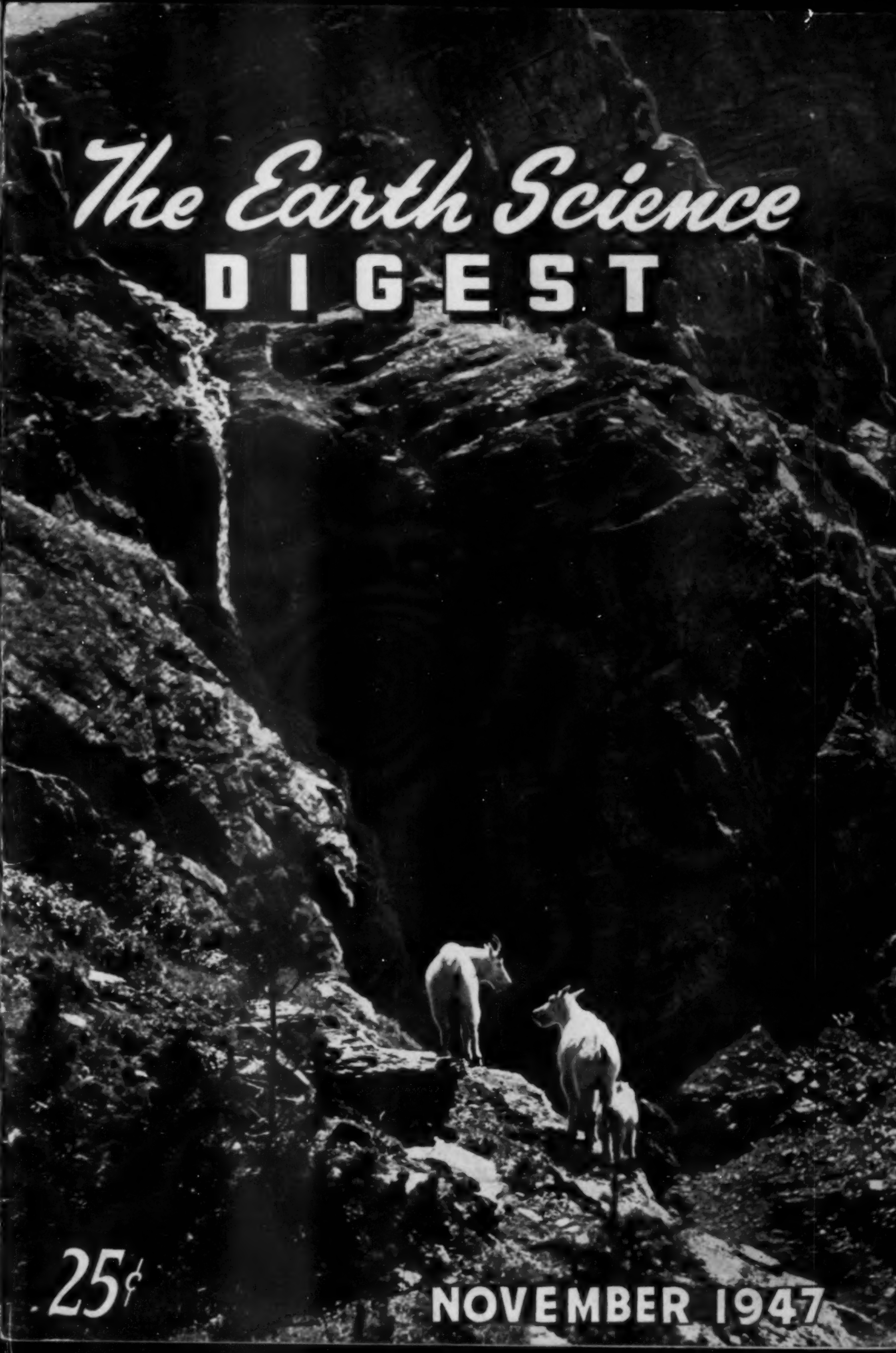
The Earth Science
DIGEST
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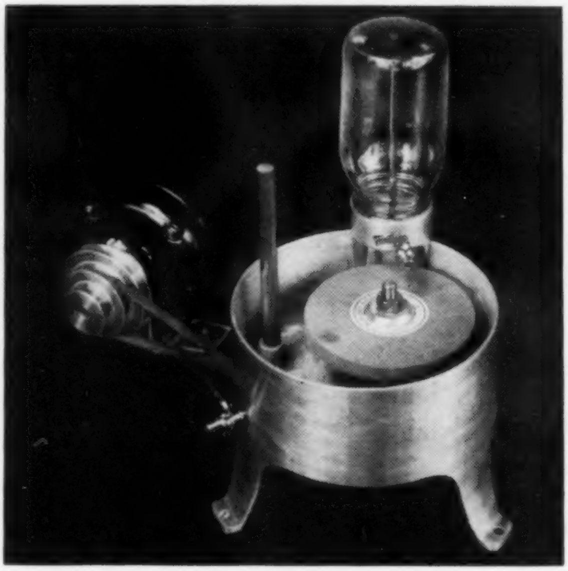
NOVEMBER 1947



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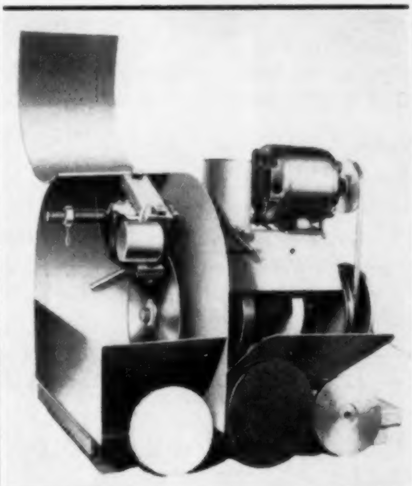

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THE ORIGIN OF DOLOMITE

Kenneth J. Rogers

Reprinted from an earlier issue of The Earth Science Digest in response to many requests.

While Marie Antoinette was shouting, "Let them eat cake," a Frenchman, T. de Dolomieu, was discovering that all that is limestone does not fizz. The region where he worked was later appropriately named the Dolomites. Were one to have asked this Frenchman to account for this non-fizzing limestone, he would have been baffled; were one to ask us to account for it we would theorize, but in the main, we are just as baffled as was he. For, where theory reigns bafflement abounds.

Today "dolomite" is used in two ways: mineralogically, as the name of a mineral, and geologically, as the name of a rock largely or wholely composed of it. The mineral dolomite is a compound of magnesium and calcium carbonates combined directly in the molecular ratio of one to one $CaCO^{3}$. $MgCO^{3}$. Pure dolomite consists of 54.35% $CaCO^{3}$ and 45.65% $MgCO^{3}$.

Dolomite, it is believed, can be either a primary or a secondary product, i.e., it can be formed through direct precipitation in sea water or by the alteration of pre-existing limestones. The limestones can be altered by the sea water in which it is lying or by hot or cold waters which may percolate through it, but in both, the manner of change is essentially the same; that is, the water carries the magnesium carbonate which replaces some of the calcium carbonate of the limestones to form dolomite. In the case of percolating waters some of the calcium carbonate may be removed to make room for the incoming magnesium carbonate by leaching. And so the chemical changes may be made at the time of deposition and dolomite laid down as we now find it, or a calcareous mass may be laid down first and then later changed to dolomite.

Most geologists agree that the majority of our dolomite deposits have been formed epigenetically. The theory involved is relatively simple. Picture, if you will, the numerous rivers which have from time immemorial emptied their cargoes into yawning receptive seas that have prevailed helter-skelter upon our earth's surface. Magnesium salts, all alkali carbonates, and an abundance of calcium hydrogen carbonate are assuredly a part of that cargo. They are carried far and wide by marine currents. In the seas a profusion of organisms dwell that can and do convert the soluble calcium bicarbonate into the insoluble calcium carbonate, and thereby, produce hard parts which either protect or support their soft parts. Upon their death they give up their skeletal part to the media in which they lived. A natural decree. Thousands upon thousands of such calcium carbonated parts are dropped and accumulated. To this may be added the lime from various lime-secreting algae.

To this batter of freshly laid calcareous sediments, a cup of magnesium carbonate is added to form dolomite. However, whereas organisms are largely responsible for the precipitation of calcium carbonate, the physical and chemical conditions which lead to the precipitation of magnesium carbonate are not known; likewise, the utilization of magnesium by organisms is unknown. At any rate magnesium carbonate does precipitate and falls to the sea floor where the lime is already lying. Then it is postulated some of the calcium carbonate is taken into solution and replaced by a chemically equivalent quantity of magnesium carbonate, or that the two carbonates lying promiscuously together are, upon crystallization of the sediments, converted to the double salt. An ideal assumption would be: $2\ CaCO_3 + MgCO_3 = Ca\ Mg\ (CO_3)_2 + CaCO_3$ in solution.

The primary theory is even simpler than the epigenetic one. The same story as has been depicted above can again be envisaged, only it need not go so far. The soluble carbonates supplied by the rivers unite with the magnesium element of the sea and form dolomite. Given such reagents, soluble double carbonate and sea water rich in magnesium, the exchange of elements is fundamental, the resultant product being dolomite which as an insoluble passes by way of precipitation from the field of action according to the laws of chemistry. However, notwithstanding the plausibility of the action, the theory of the thing becomes apparent when we learn contrary to expectations that examinations of present sea floors have revealed very little dolomite.

We can with justification say that the preponderance of our dolomite originated in warmer climes, for in warm water a sharp increase of denitrifying bacteria is noticeable; and these organisms by their physiological processes are responsible for the throwing down of huge quantities of lime carbonate. Then too, tropical rivers carry magnesium and calcium salts to the oceans at a faster rate than elsewhere. The core and samples from a well drilled on Funafuti Atoll shows that magnesium carbonate decreases at depth. This would seem to prove that dolomite originated in shallow water, but certainly does not prove that shallow water is requisite for the birth of dolomite. That dolomites were universally formed under reducing conditions seems likely inasmuch as ferrous iron is present in a surprisingly large number of the dolomites. The iron percentages runs anywhere from 10% to less than 1%. Since ferrous iron is readily oxidized, its presence negatives the view that dolomites developed through replacement by ground water. The big three involved in producing dolomite, i. e., time, temperature, and pressure are, as usual in the fashioning of Nature's wares, mysteries. Laboratory estimates have been made based on attempts to simulate nature's environmental conditions, but much more has yet to be done before the origin of dolomite can pass from the realm of theory.

The fact as to how magnesium got into dolomite may be somewhat of a puzzle to all peoples, but that it is there the English can well testify. When the order was given to build the houses of Parliment, dolomite was chosen as the building stone, and the buildings subsequently became, because of the sulphurous fumes, of nearby potteries, corroded with a layer of epsom salts affording to the people who would but scrape the walls, a free purgative.

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Vol. II November - 1947 No. 3

Contents

EDITORIAL

Back in 1936, a man in California began grinding a 20-ton mass of optical glass. He and his capable assistants left the job for more urgent duties during the war years and resumed the work when peace came.

A parabolic surface was ground accurately to within two-millionths of an inch. Five and a quarter tons of glass were removed during the work. Thirty-one tons of cutting and polishing compounds were used, ranging in hardness from silicon carbide to hematite.

The task was completed the other day, eleven and a half years after the work was started. The man who directed the grinding was Dr. John A. Anderson.

If you haven't guessed it, the finished product is the mirror disc for the 200-inch telescope of the California Institute of Technology, now ready to be trucked from Pasadena to the Palomar Mountain Observatory. There it will undergo an aluminum bath in a special tank on the telescope site to make the disc a true mirror. A motorcycle escort will protect the 15-ton crated disc on its way.

A task which has been called "man's most daring optical grinding job" is done. A new eye has been fashioned to look beyond the frontiers of space.

COVER PHOTO

In western Montana, the Belt system of rocks of the Proterozoic Era attains a thickness of more than 35,000 feet. Magnificent cross-sections of these ancient argillites and limestones may be seen by the hiker and trail rider, particularly where Ice Age glaciers cut deeply into the ranges.

This month's cover photo shows a great cirque wall on the west slope of Gunsight Pass, in Glacier National Park, with a family group of mountain goats evidently contemplating climbing down the cliff face, no great problem for these sure-footed mammals, which are not true goats but goat-antelopes, related to the European chamois. Photo by the Editor.

NEXT MONTH!

The December issue of The Earth Science Digest will include another of the fascinating Lost Mines stories by Victor Shaw. "There ought to be a law against your stories," writes a subscriber. "My grandfather wants to pack up and get going —and I think I'll go along!"

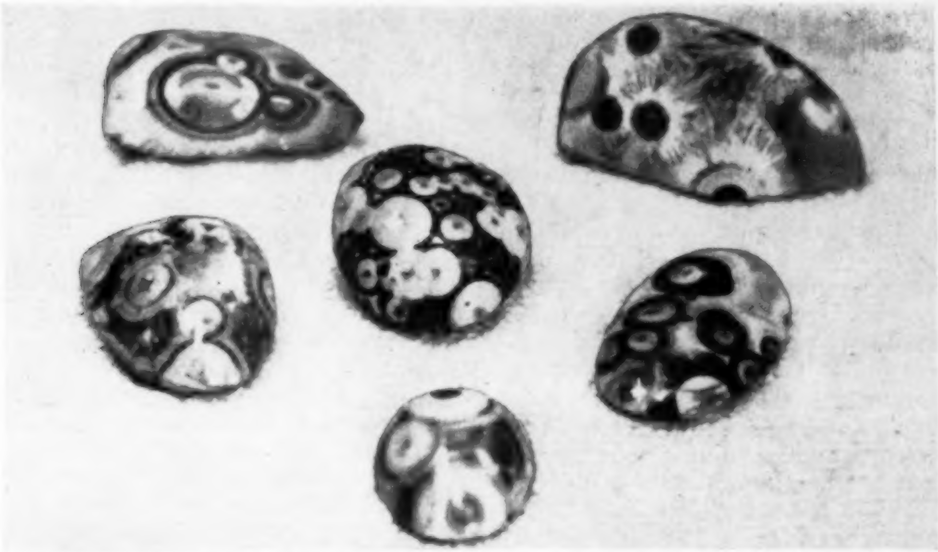
Readers who have specimens of dinosaur bones in their collections will be interested in "What Happened to the Dinosaurs?" by Prof. Russell C. Hussey.

The search for mineral wealth in Newfoundland extends beneath the Atlantic. Read "Iron Under the Sea".

All in your December number of *The Digest.*

Zeolites Merit More Attention by Lapidaries

Thomsonite and Natrolite Are Members of Interesting Group—Make Attractive Ornamental Stones



Attractive thomsonites with fine color patterns. These were collected at Grand Marais, Minnesota, and polished by John F. Mihelcic and Hugh H. Millar, of the Michigan Mineralogical Society.

RICHARD M. PEARL
Colorado College, Colorado Springs

Thomsonite and natrolite are the chief members of the great zeolite family of minerals which serve as gems. Under nomenclature that is now regarded as obsolete, they would have been referred to as "semi-precious stones." Modern terminology refrains from making a distinction between alleged precious and semi-precious stones, but instead calls them all gems when used for personal adornment. When either thomsonite and natrolite occur in massive or fibrous forms coherent enough to admit of being polished, they make attractive ornamental stones that should be even better known to lapidaries than they are.

Thomsonite gems are especially well known to collectors in the Lake Superior region. Originally found in water-worn pebbles on the shores and used as a local curiosity, these thomzonite specimens have attained world-wide recognition. The concentric eye-like mottling is marked in white, red, green, and yellow. The specimens with greenish color are known by the old name of lintonite.

Natrolite, like thomsonite, occurs in many localities. The pretty pink material from Red Hill, Pennsylvania, is especially choice and polishes well.

Ever since the earliest days of mineralogy, the family of zeolites has been the subject of theory and investigation because of the large number of species existing within a limited range of composition. Many studies have consequently been made to show the relations between the members of the family.

The work of Gustav Tschermak was the best according to the older theories. Alexander Winchell at the University of Wisconsin began in 1925 to publish his important research on the newer structural concepts. In England Bannister and Hey have combined chemical studies and X-ray work since 1931. The late Harry Berman of Harvard University synthesized these results in 1937 and added his own valuable contribution.

The zeolites are a family of hydrous silicates closely related to one another in chemical composition, in conditions of formation, and hence in mode of occurrence.

Their name comes from two Greek words meaning "to boil" and "stone" because of the interesting observation that they intumesce or boil when heated. The water that they contain is so different from the ordinary "water of crystallization" of other minerals that it is called zeolitic water. This water is given off easily and continuously, not in certain amounts at definite temperatures as in other hydrous minerals.

Even more amazing is the way in which, after losing their water by being heated, they will take up water again if exposed to moisture. And not only water, but almost any liquid or gas, many times the volume of the mineral itself. Experiments have showed that alcohol, ammonia, iodine, hydrogen sulfide, ordinary air —these and still others are absorbed. Water, however, is preferred, and after a crystal has taken up some other fluid it will expel it and absorb water instead if it is brought into contact with the water. The atomic structure seems to remain constant until the zeolites have been nearly dehydrated, and the framework may be preserved even after the water is entirely driven off. The optical properties change gradually as the heat is applied.

Chemically, the zeolites are remarkably similar to the very important minerals known as the plagioclase feldspars. All the zeolites are silicates of aluminum; individual ones may contain sodium, calcium, less frequently potassium, some barium, some strontium. The sodium and calcium replace each other. In fact, the composition in some cases corresponds directly to a feldspar and water. Doelter found that he could fuse some zeolites and slowly recrystallize them, getting plagioclase feldspar.

Along with the strange inteumescence and absorption of foreign fluids, another peculiar property of the zeolites is known as "base exchange." This means that a "base", in this case one of the alkali metals, can be substituted for by various metals. For example, silver can be added artificially to a zeolite by replacing sodium. Such a property can be used to advantage as a water softener by taking up calcium, which is the cause of "hard" water, in place of the base already present in the mineral. Natural zeolites were formerly used for this purpose more than they are now, having been superseded by greensand from New Jersey and by so-called "artificial zeolites" such as Permutite.

Whereas the plagioclase feldspars are a single group related in crystallization, the zeolites belong to four of the six crystal systems. The members of one group of zeolites may even belong to several different crystal systems. Half of the species are monoclinic and most of the rest are orthorhombic, but some are hexagonal and some isometric. Both thomsonite and natrolite are orthorhombic.

All except one of the many zeolites are always formed as secondary minerals. They form at low tempera-

Thomsonites, with coloration and pattern resembling Paisley shawls, are the favorite specimens of many collectors. These are from the collections of John F. Mihelcic and Hugh H. Millar, of Detroit.

tures, usually by the reaction of heated water upon feldspars or related minerals. The most common occurrence of zeolites is in cavities and veins in basic igneous rocks, but they have various other homes. The zeolites keep one another company; wherever one is found, others are likely to be present. The common associates of zeolites are pectolite, apophyllite, prehnite, datolite, and calcite.

About 25 countries and states are listed as important localities for zeolites. Some species are more important than others at certain places. In Germany, at Andreasberg in the Harz Mountains and at Baden in the Black Forest, and at the Kongsberg in Norway, zeolites are found in silver veins and lead mines. Belief has existed that the zeolites may be favorable to the deposition of silver, but this is improbable. Besides the copper district of Lake Superior, other great zeolite localities in the United States are in the trap-rock quarries of northeastern New Jersey and the two Table Mountains at Golden, Colorado. Across into Canada, the Bay of Fundy district in Nova Scotia is as famous for its zeolites as for its high tides. Many zeolite localities occur in the lava region that extends from Iceland across the Giant's Causeway in Ireland to Scotland and the islands nearby. The vast lava flows of India are also noted for zeolites.

PRICE OF EROSION

How much soil is carried to the Mississippi delta each year which could be saved for agriculture? The total is estimated at 730 million tons, or a 11,000-pound load for every man, woman and child in the United States if our people were to carry the material back to its place of origin.

QUIZ CORNER

If a collector offered you a "Cape Ruby" would you be getting (a) a ruby? (b) a "carbuncle"? (c) rose quartz?

If a collector sold you an "Arizona ruby" what would he deliver?

(See Page 22)

THE STORY OF THE ROCK CYCLE

Never a Dull Moment for the Collector When He Knows Varied Origin of His Specimens

W. D. Keller
University of Missouri

The rock cycle, or rather the story of the rock cycle, is aptly a condensed digest of the treatise on earth materials. It covers a "briefing" on petrology and it surveys the mineralogy of rocks. Moreover, it constitutes a demonstration of the principle which governs the behavior of rocks and minerals—*the low of stability of rocks and minerals.* The rock cycle comprises the most fundamental sequence of rock behavior in our earth science.

Because it is a cycle one should be able to enter it anywhere and by following it throughout should emerge again at the starting point. Let us try that, and for convenience start with the igneous rocks, which long ago were called the primary rocks.

Igneous rocks result from the crystallization of minerals from the magma, a hot silicate solution, or the quick freezing of the solution to a glass. Under those conditions such minerals crystallize as the orthoclase and plagioclase feldspars, the amphiboles (hornblende), the pyroxenes (augite, diopside) the micas (biotite, muscovite) quartz, pyrite, olivine and various accessory minerals. These minerals form in an environment of high temperature, usually high pressure, reducing conditions (non-oxidizing, relatively speaking) and where there is not a great excess or renewal of water (steam) or carbon dioxide. The igneous minerals are therefore "at home" in the environment of their formation.

This relationship brings us to the concept of the law of stability of rocks and minerals. It may be stated as follows: *Rocks and minerals remain stable so long as they remain in the environment of their formation, and when their surrounding environment changes the rocks and minerals change to new forms or compounds or minerals which are stable under the new environment.* The preceding sentence may seem childish in its simplicity and something to be taken for granted, but when its implications are followed in detail the result may become so momentous as to be truly astounding. Suppose we illustrate the law by tracing a granodiorite, or a hornblende bearing granite, as it is transferred from its original environment of solidification to a new one at the earth's surface.

The coarse-grained granite was formed within an intrusive mode of occurrence buried deeply within the earth's crust, that is in an environment truly representative of the conditions (temperature, pressure, etc.) enumerated before. When this hornblende granite is brought to the surface of the earth either by faulting, or by erosion of the rocks above, it finds itself in an environment in radical contrast to that of its formation. Now its temperature has dropped from, say 1500°F., to that of the earth's surface, perhaps within the

◄ Rocks in a new environment. Once buried thousands of feet beneath the surface, ancient limestones and argillites (hard, indurated shales) of Proterozoic age, have been lifted thousands of feet above sea level in Glacier National Park, Montana, and now are being attacked by the agents of weathering. Below is the tongue of Sperry Glacier. The dark band high on the cliff is the exposed edge of a great sill of diabase, intruded as molten rock between sedimentary layers.
—Earth Science Digest Staff Photo.

Late in the geologic history of North America numerous volcanoes of the explosive type raised their fiery crowns above the clouds in the Pacific Northwest. Yesterday's deep molten rock thus created today's scenery. One of these extinct, or dormant, volcanoes is Oregon's beautiful Mt. Hood, 11,225 feet high.

range of temperature from 110°F. down to 20° below zero, and crossing the significant freezing and thawing point of water-ice. The high pressure which existed in the intrusive body has given way to almost negligible pressure at the earth's surface. Oxygen from the atmosphere and that which is dissolved in ground water is present in great excess at the earth's surface, and is abundantly available for aggressive attack on any of the minerals or portions of the rocks susceptible to oxidation. Soft rain water and that coming from melting snows is *renewed* time and time again to attack, to combine with, and to dissolve and carry away any rock or mineral substances which water may affect. It should be noted that although water, (steam) and other solutions were present as mineralizers in the magma they were saturated with rock-forming constituents and therefore lost their potency as rock destroyers. The mild but often repeated rains and snow water, although less powerful individually than the chemically charged mineralizers, percolate through the rocks many times each year so that in the aggregate the weak surface water becomes paradoxically actually very powerful. Weak acids in the ground water which accelerate the hydrolysis of the silicate minerals are generated by the solution of carbon dioxide from the soil atmosphere and the ordinary atmosphere, organic acids, and acid clays, and locally by sulphuric acid derived from oxidizing pyrite and other sulphides. Mechanical strains are set up in the rocks by freezing water, temperature changes, and by the expansion of hydrating minerals. What a change this environment is from that under which the granite was originally formed.

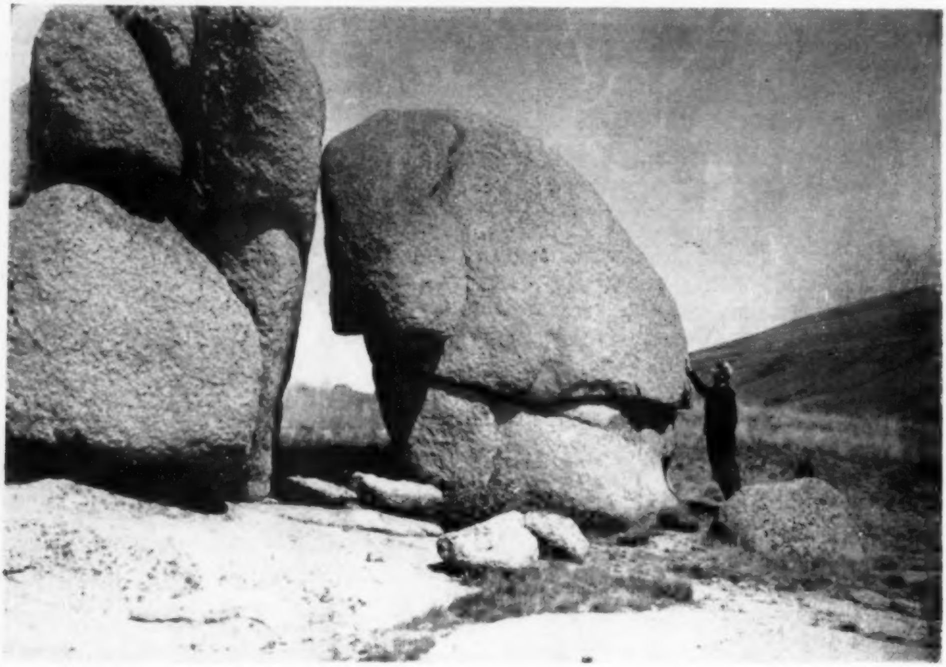
It is no wonder that the granite is no longer "at home" in this new environment. The constituent minerals are no longer "at home", and by following the law of stability of rocks and minerals they change to new minerals and compounds which are stable under the new environment. The new environment is called a weathering environment. It is a preparation for transportation and the first step in the formation of sedimentary rocks. The path on the rock cycle is pointed toward the station of sedimentary rocks. But before proceeding too far, let us return to the weathering igneous rocks and review what minerals are being formed where the weathering is going on.

The feldspars, the amphiboles and the pyroxenes all contain an alumino-silicate (aluminum, silicon, and oxygen) in their chemical make-up, and as they undergo hydrolysis one of the products of chemical reaction is a clay mineral. The clay minerals are the most abundant secondary or weathered minerals to be formed, because their source material constitutes the most abundant minerals in the igneous rock. Along with the formation of clay minerals from the feldspars, etc., a little soluble silica is also released into the streams and waters draining the rocks. Greater quantities of sodium, calcium, magnesium, are taken into solution by the groundwater and are carried downward by the streams eventually reaching the ocean. The sodium in the salt (sodium chloride) of the sea was derived in the main from the weathering of rocks at the earth's surface which contained sodium. Because of its high solubility the sodium of the ocean has been accumulating in solution there throughout the geologis eons. The soluble calcium and magnesium (soluble in groundwater) are much less soluble than sodium in the ocean and consequently have been deposited as sedimentary limestone and dolomite, which we will discover a little bit later.

Most of the iron which is present in the igneous minerals, like that in hornblende, augite, diopside, and pyrite, is oxidized during weathering to form the red or brownish insoluble hematite and limonite (iron oxides) which remain behind, adhering to clay or sand, and giving rise to reddish, yellowish, or brownish soils and residual rocks. Quartz is only slightly affected by ordinary chemical weathering and it remains behind as an insoluble residuum or it is carried in suspension by the streams along with the insoluble clay and iron oxides. Most of the potassium which was present in the igneous minerals after being released by weathering process is absorbed by the clay and therefore is not released for removal in solution by the streams going to the ocean.

Under this new weathering environment develop the relatively soft and the relatively voluminous hydrates, carbonates, and oxides, such as the clay minerals (kaolinite, beidellite, illite) and the iron oxides (hematite, limonite) the broken down quartz sand, and soluble calcium, sodium, and magnesium, and a little, colloidal (soluble) silica. These new substances are stable under the new or weathering environment. Their formation is in obeyance to the law of stability of rocks and minerals.

The conventional course of events for these newly formed minerals after weathing is a stage in transportation, then deposition, and finally consolidation (including diagenetic changes). After consolidation the sediments have become sedimentary rocks. More specifically, the clay minerals along with a little sand, silt, iron oxide, or carbon have be-



These huge residual masses of granite along the summit of the Big Horn Mountains in Wyoming resemble the mysterious Easter Island statues. They were formed by the weathering of jointed granite, water and air attacking the rocks along the joints and gradually rounding off the great blocks. The jointing resulted from contraction when the once-molten rock was cooling far below the surface. Erosion now has exposed the granite core of the range. —Earth Science Staff Photo.

come shales, the sand grains have been cemented to become sandstones, the soluble calcium has become limestone, or calcium and magnesium have become dolomite. The soluble silica has given rise to chert and flint, and under conditions where extreme evaporation of an arm of the ocean has taken place deposits of gypsum, rock salt, and possibly potassium salts (like those in our west Texas-New Mexico region or at Stassfurt, Germany) will be precipitated. The sedimentary rocks just mentioned are stable, and are "at home" in the sedimentary environment at or near the earth's surface. Here is a second stage in the rock cycle.

The sedimentary rocks which were formed on the sea bottom and which are stable while so buried become unstable if through some earth movement they are raised up and exposed at the earth's surface. Under the environment of exposure they again undergo weathering and may be returned to the ocean. Here then is a small sub-cycle within the larger rock cycle.

Not all the sedimentary rocks are raised to the earth's surface after their formation. Instead they may be buried layer upon layer, deeper and deeper, until either through very deep burial or by diastrophism they are surrounded by a new high temperature and high pressure environment which is as radically different from that of their formation as was the transfer of igneous rocks from the place of intrusion to the earth's surface. Imagine, if you will, a deposit of shale and limestone buried tens of miles beneath the earth's surface and heated to a high temperature, either by the conventional increase in temperature toward the earth's center, or by an intruding magma which is being emplaced near the buried sedimentary rocks. Those shales and limestones are no longer "at home". In obeyance of the law of stability of rocks and minerals they change to the new mineral and rock substances which truly are stable under the new environment, that of metamorphic conditions. A new group of metamorphic minerals and rocks will evolve at the expense of the old sedimentary material. In place of the dull, earthy, soft, highly-hydrated shale under the metamorphic environment, a new brilliant, glistening micaceous slate, scist, or hard amphibole or pyroxene may form by crystallization. Fresh appearing, crisp marble may result from re-crystallization of limestone. Quartzite, hornfelses, gneisses and other metamorphic rocks may develop. Why does this take place? Because the sedimentary minerals were not "at home" in the metamorphic environment. Instead, because such metamorphic minerals as tremolite, actinolite, hornblende, the micas, garnet, staurolite, chlorite, kyanite, sillimonite, the feldspars and other silicates are stable, that new metamorphic group of minerals is being developed. We have arrived at another station in the rock cycle, the metamorphic station.

Not only do sedimentary rocks undergo metamorphism but igneous rocks which are subjected to another stage of higher temperature, or those which are subjected to powerful movements, shearing, stretching, or compression may undergo deformation or re-crystallization to form banded or re-crystallized metamorphic rocks. Even previously metamorphosed rocks may undergo either more severe or less intense metamorphism and be changed to meet the conditions of a new environment so that metamorphic rocks may be said to be re-metamorphosed. Metamorphism is a variable but important station on the rock cycle.

Suppose that these metamorphic rocks which are formed under conditions of high temperature and high stress are transferred to the earth's surface through denudation above, or by faulting, what is their fate? They have been thrust into the weathering environment, and just as would be expected they undergo weathering and change to new minerals or compounds which are stable under the weathering environment. Metamorphic rocks weather to the same group of minerals which resulted from weathered igneous and sedimentary rocks under similar environment. How fortunate we are indeed that all types of rocks weather to the same relatively few secondary or weathered minerals, with the result that soils the world over are built up of nearly the same species of minerals, only in different portions. Think how convenient it is that clay and iron oxides are weathered similarly from granite in Iowa, in China, in Russia, and in South Africa. Consequently, lettuce, radishes, beans, cotton, and crab-grass (in lawns) will flourish whether the parent rock has been igneous, sedimentary, or metamorphic. Think what complications would arise if corn could be grown only over limestone, wheat only over mica schist, and tobacco only over diamond-bearing peridotite! The point of this is that there is a common suite of minerals formed under the weathering environment just as there are a few stable minerals which are formed under the igneous and the metamorphic environments. Metamorphic rocks undergo weathering, transportation, deposition, and consolidation to form new sedimentary rocks. They return to the sedimentary station on the rock cycle.

All that remains to complete the

major cycle is to make igneous rocks out of the sedimentary rocks and metamorphic rocks, and to remelt some previously existing igneous rocks. The fact that more or less granite has been formed by the recrystallization of schists and other metamorphic rocks after being permeated by mineralizing solutions is generally accepted by petrologists, and has been called *granitization.* Insufficient evidence has been accumulated by petrologists so as to be convincing to all investigators the exact magnitude to which granitization has operated but the principle has been accepted. The solution of inclusions of igneous, metamorphic, and sedimentary rocks by an invading magma, and subsequent crystallization of the dissolved products is also recognized. Therefore from an academic standpoint at least, we are correct in completing the rock cycle by recognizing the development of the igneous rocks from any other preexisting rock type. The cycle is complete, we have returned to the starting point.

We should never run out of rocks on this earth so long as it continues anything like the present. There should always be plenty of material for earth scientists to enjoy. The science of geology will never lack for raw materials to be studied. "Rock hounds" should never be bored with life!

OIL IN A GEODE

A geode full of crude oil was discovered recently in a creek bed in western Illinois, near the Mississippi, by Wilson H. Henderson, of Route 2, Galesburg, Ill.

Mr. Henderson reports that the geode is gray and about the size of a fist. He writes: "I have boiled the geode in lye, sal soda and various kitchen cleaners, but have been unable to clean the crystals. The oil is black and thick and was sealed in. It was not until I got home and broke open the specimen that I found it to be unusual.

"The geologist for the Sinclair Oil Co. to whom I wrote said that while geodes containing small quantities of heavy petroleum are not unique, they are certainly unusual. He also states that the literature makes numerous references to such specimens, and that the origin of the contained petroleum is not completely understood, but that it is assumed to be derived from organisms contained in the formations in the vicinity of the geode's locality. It does not necessarily indicate commercial quantities of oil in the vicinity."

Mr. Henderson is interested primarily in semi-precious stones and will exchange his specimen if a geode collector wishes to have it.

IT CAN BE DONE

Have you ever wanted to photograph your fluorescent minerals in color under ultra-violet or "black" light?

A patient and inventive photographer, James Viles, accomplished the difficult task recently for *Science Illustrated*. He used a one-shot camera of his own design. Lamps used were ordinary 750-watt spotlights and the 3,600 Angstrom unit Stroblite (ultraviolet).

After eight hours of experimentation in an effort to balance light from the minerals and the Mazda light simultaneously, he solved the problem by making two separate carbro color prints and stripping them together. The first of these was of the

(To Page 29)

FAMOUS LOST MINES

(Seventh of a Series)

VICTOR SHAW

THE LOST TUB PLACER

Judged by data compiled from many sources these diggings seem to be situated upon a lower flank of one of several mountain ranges, in the desert of southeastern San Bernardino County, California. Rich gold gravel is said to be exposed there on a low mesa, or table land, hemmed in on the mountain flank by three high peaks and facing the open desert.

The exact position of this range having the three peaks enclosing the mesa is not known, with this single

exception: most all descriptions place it in a general southerly direction from the town of Homer, at a distance of some twenty hours travel in the saddle. Homer is a small station on the Santa Fe railroad, some fifteen miles west of Needles, the latter a division point, on the Colorado River.

This could place it somewhere in the vicinity of the Lost Arch Placer, described in the August issue of *The Earth Science Digest*, although as will be seen it is not likely to be in that vicinity. Also it could be at the southern end of the Mohave Range, or on the east or west sides of the southern Turtle Range, or the southeastern side of the Old Woman Range and the last named seems the most probable.

Now, as may have been noted with other lost mines, there are several different stories regarding its original discovery. One that was published rather recently concerns a party of Mexican miners, who in the early 1820s were packing equipment northeast, to prospect the then new placer diggings at La Paz lying just east of Ehrenberg. One evening this party is said to have camped somewhere along the southeast side of Old Woman Mountains, planning to travel on the next day.

But, in hunting their hobbled pack mules next morning, some of them crossed a mesa in the nearby hills, where they found an area of gravels stained red by oxidized hematite. It looked to them like a possible gold placer deposit, so as they had the proper tools they panned some of it and found it to be extremely rich, some pans yielding as high as seven dollars, when taken next to the shallow bedrock.

This was in late January, when some water still remained in the hillside gulches; so they made a permanent camp and worked gravels until the water failed, and in that time, according to this tale, recovered some $30,000 in gold dust and nuggets. They then left those diggings for the summer, but on their return failed to find the place.

This story goes on to say that years later other prospectors stumbled upon that place and found an old wooden tub not far from it, which showed it had been worked for placer gold, thus causing it to be known afterward as the "Lost Tub Placer".

This story has many discrepancies: one is that the Mexicans could not find the placer again, after taking much gold from it, when they were stated to have been experienced desert prospectors. But the most striking error is that it claims that Coffin Spring was nearby, whereas that spring is mapped in Turtle Range twenty air miles away. There are other discrepancies, but the two just mentioned are enough to discredit it. However, the following story not only seems plausible throughout, but its major points may even be factual.

According to the account now presented, the original discovery of the Lost Tub diggings was made by Piute Indians whose village was at Piute Bend, a small reservation a few miles north of old Fort Mohave, on the Nevada side of the Colorado River. In the 80's the Piutes used to bring gold to Fort Mohave in the form of dust and nuggets, some of the latter being as large as an ounce or more in size. The post trader and nearby miners always thought this gold came from desert areas only a few days travel from the reservation, but in what direction they never knew. The Indians guarded their secret well and no amount of cajolery ever induced them to talk about it.

At this time the Piutes had no use for such a soft metal, except perhaps as ornaments to string on a squaw's neck; but since white men seemed so crazy to get it, the Indians bartered it at a fraction of its value for merchandize they craved, such as guns, black powder, gun caps, clothing, candy, or gewgaws for their squaws. But all efforts to learn the source of the gold failed and attempts at trailing them also proved useless. Always the Piutes were too clever for them.

Then one day in the early 80's, a white man drifted into the reservation; said to have been a prospector named Jamison, which is all that is known of him. At any rate, Jamison made friends of the tribe to the extent of marrying one of the young squaws, Indian fashion, and settled down to live with them. Possibly before his arrival he had heard about the Piute gold, but if so he never admitted it, yet he took the only way to win their confidence and learn its source.

After living with the Piutes for some time, Jamison gained a fair working knowledge of their language and, no doubt with the aid of his squaw, found out something about where they got their gold. As a matter of fact, he finally persuaded his squaw's brother to take a saddle trip to the place where many nuggets lay exposed on the ground. But his guide warned him that it was impossible to go there safely, except in certain winter months. There was no water at this place, so only when there was snow on the ground was it wise to venture there.

Now in this region snow seldom falls in winter, even in the higher mountains, and Jamison was forced to wait two years before the necessary conditions prevailed. Then his guide saddled two ponies and two pack mules and they slipped away from the reservation at night, on a roundabout course designed to mislead any would-be followers.

It proved to be a long tough journey following various washes, across numerous desert valleys leading southwest, and climbing through a few snow-mantled mountain passes; until at last they reached a small mesa below three high snowy peaks, where there was no water except what they melted from snow for themselves and the saddle stock.

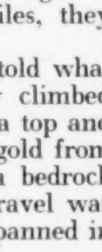
They camped only long enough to fill the rawhide kyacks on the pack mules with rich gravel scraped from beneath the snow—gravel that was full of nuggets large and small beside fine gold and dust. It made heavy loads for both mules, when they broke camp and started back, but they reached the reservation in three days arriving at night. The gravel then was washed in the river and a surprising amount of gold recovered, half of which the Piute turned over to Jamison.

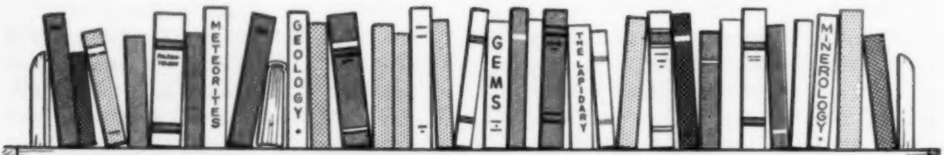
It is what followed that leads one to suspect that Jamison joined this tribe only to learn where they got their gold, for he at once wrote to a friend in the East that he had a placer that should make them both rich, if he would come and buy half the mining outfit. Nothing is known of this friend, except that his name was Fields, and even that was never confirmed. Anyway, Jamison's story of the wealth that lay waiting brought Fields to Fort Mohave eager to examine the remarkable store of gold, which he wanted to see before buying equipment.

So after explaining to his squaw and the tribe that he had to make a business trip west he then went with Fields to Homer on the Santa Fe railroad. There they bought a span of mules and a buckboard, on which they loaded bedding, food, a barrel of water, and also a big tub in which to wash the gold gravels.

By this time it was late spring, but Jamison knew that he could easily find the place and figured the barrel of water would be plenty for their needs, including the return journey. He then set out south through Homer Wash, until he recognized certain landmarks he had spotted on his saddle trip with the Piute; and after driving all day and most of the night, they reached the mesa and three peaks at daybreak next morning — a distance of some forty miles, they later estimated.

Years afterward, Fields told what then transpired: that they climbed the short height to the mesa top and started at once to pan the gold from the gravel, which was on bedrock very near surface. The gravel was shovelled into heaps, then panned in





The BOOK SHELF

The Gem Hunter's Guide by Russell P. Macfall. A list of all important gem locales in the United States with information on not only where to find gems, but how to find them. Well illustrated. **Price: $1.00.**

Handbook of Uranium Minerals by DeMent and Dake. An exposition and catalog of the Uranium and Thorium minerals, including methods for their detection, location and exporation. An invaluable aid to all prospectors and miners on the lookout for these important minerals. **Price: $1.50.**

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The Art of Gem Cutting by Dake and Pearl. Anyone who contemplates pursuing the hobby of gem cutting should have a copy of this book. Written by H. C. Dake, editor of The Mineralogist Magazine, and Richard M. Pearl of Colorado College, it presents a wide variety of material on the most interesting of all hobbys. **Price: $1.50.**

HISTORICAL GEOLOGY by Prof. Russell C. Hussey. The geologic history of North America during two billion years. More than 300 illustrations. The story of the development of the plants and animals and the early history of man told with a minimum of technical terms. A text used at the University of Michigan and many other schools. This is an invaluable addition to every earth science library. Reviewed in this issue. **Price $3.75.**

BENJAMIN SILLIMAN: Pathfinder in American Science. Just off the press. Recommended by the Book-of-the-Month Club. The life of "the father of American scientific education," interestingly told by John F. Fulton, Sterling professor of physiology at Yale, and Elizabeth H. Thomson, research assistant in the historical library of the Yale University School of Medicine. **Price: $4.00.**

Jewelry, Gem Cutting and Metalcraft by W. T. Baxter. Detailed methods of jewelry making, metalcraft, and gem stone cutting. Gives practical hints as to the best tools and materials, and such incidental information as how to cast rings, etc. **Price: $2.75.**

The Earth Science DIGEST

BOX 581 ANN ARBOR, MICHIGAN

the tub using water taken from the barrel. He said that gravel seemed to be almost half gold, with so many big nuggets that he could hardly believe it possible.

In fact, it took so long to pan it down closely, that in order to save time they very soon began to just pick out the nuggets dumping the fine stuff into the tub. And they worked feverishly, as most anyone will under such circumstances; and even lost track of time, obsessed by the wish to get all the gold they could in one short day. But late that afternoon they were brought to their senses by the sudden realization that the water supply was getting dangerously short. In fact they had used to much while panning, that a hasty estimate of what remained made it doubtful if it would last them back to Homer.

Anyway, they must start back at once. A desert mule is tough, Jamison knew, and by pushing the team hard all night, they had a fair chance to reach the railroad some time the next morning. But, even travelling in the chill of a desert night, Jamison had yet to learn how much water mules need to haul such a heavy load forty miles through the soft and very uneven desert sands.

However, they lost no time in getting on their way.

After loading the weighty canvas sack of gold, they cached the goldpan and tub of gold sands in a cave they found, in a gulch of the nearby mountain flank. Then, making up a light lunch to be eaten on the way, they hopefully set out in the moonlight headed north. The team had been given all the water used in panning, and being well rested and fresh they at first made very good time.

But it was a long pull and of course they couldn't travel a straight course. There were high sand dunes to circle, and an unending series of sagebrush clumps and greasewood; beside which the sandy desert floor was covered with scattered boulders, with here and there acres of sharp pointed rocks impossible to cross, to say nothing of the occasional drainage channels eroded by the spring run-offs.

It took time to circle the obstructions, but having much experience coming through it the previous day, they merely cursed the delay and pressed on halting only to give the team a ration of water. At least, they congratulated themselves, they couldn't lose the way since there were mountains on both sides showing plainly even by moonlight.

The chief obstacle was the slim ration of water and food, as was always the case in desert travel before good roads made automotive transport possible. Cars now carry enough for many days of travel. But, for Jamison and Fields in 1883, daylight came too quickly with its blistering heat and hot winds laden with blasting clouds of sand.

Soon the mules slowed to a walk and growing thirst made them stubborn and balky. As near as they could guess they had come better than halfway, but seemingly endless miles still lay ahead, where those quivering heat waves and twisting columns of sand devils hid the view. At last with all water gone and the mules about ready to quit and lie down in their harness, Jamison and Fields had to get out and plow on through the sand dunes, one on each side of the team the better to keep the weakened animals stumbling ahead toward their goal.

It now had become just a grim struggle to survive. Long ago they had thrown away everything but the canvas gold sack, to lighten the load. Yet they were frequently forced to halt for brief rests and the mules stood with lowered heads shaking with exhaustion. Always it was harder to arouse them and lash them into motion—to take faltering steps on for a mile or so into the hazy dust veils in the north.

And this endless nightmare of effort continued throughout the following night, the two men and their team growing constantly weaker, for if now the mules once laid down they'd never get on their feet again. But desperately they fought slowly on until, in the dawn of the next morning, they caught sight of what for so long they had hoped to find. Far left upon the desert rim there was a thin gleaming line, the telegraph wires strung upon poles set at regular intervals along a railway. It was the Santa Fe and no doubt there was a water tank somewhere along the line.

It still was miles away, but already they imagined streams of vivifying moisture laving their parched throats and cracked- swollen tongues, and with feeble cheers they lashed the team into motion and struggled toward it. At long last, through a notch in the dunes, they saw a tiny cluster of weather-beaten shacks. The mules saw them too and using their last reserves of strength, men and team staggered on toward that welcome promise of unlimited water and rest.

The place proved to be the tiny hamlet called Blake, though now mapped as a railroad division point named Goffs, and there was water in plenty. Also some section hands and a few miners were living there temporarily. As Jamison and Field drew near they saw a man who sat watching them on a bench, before the only saloon in the place. He arose and hurried toward them, as they dropped from complete exhaustion.

Much later they learned that it took several hours to bring them out of their stupor, and it was two days before their minds cleared enough to tell a straight story of what they had been through. And they also learned that their first question had been about the sack of gold left on the buckboard. It was handed them intact, with the assurance that their team had been carefully tended and was in good shape.

Then, when their gold was weighed and its value estimated at close to $15,000, there was an immediate stampede for the new diggings, which emptied Blake of every man but the station master; although all they had been told was that the placer was straight south down the Homer Wash about forty miles, if they'd just follow the buckboard track. However, that stampede was in vain, for the wind had obliterated most of their wagon tracks and none of them found a trace of the rich placer.

As for Jamison and Fields, a week or more passed before they were able to travel. Then with a new outfit and the gold, they drove east to Needles; where Fields, with his share of the gold, went home by train to get capital to properly develope their discovery.

But it was otherwise with Jamison, who still was far too weak to travel and should have rested for several weeks longer. He realized this, but planned to do so in the quiet of his reservation home. So he drove there by way of Homer, growing weaker with every mile covered, until when he arrived he collapsed with a high fever, and the Indians had to carry him to his tepee.

His heart may have been damaged, or perhaps pneumonia set in; but, although his squaw nursed him devotedly, and the Piute shaman fed him sacred meal and boiled herbs and wove magic incantations to drive away the demon of illness, he sank into a prolonged coma and died. His relatives were unknown so his squaw was made wealthy — for an Indian.

News of his death reached Fields, perhaps through the commandant at Fort Mohave. At any rate, Fields returned at once to Homer, as now he was not only sole owner of the remarkable placer, but also was the only white man having any idea of its location. His idea was to stake and record it, but with his terrible experience fresh in mind not even the wealth it represented could induce him to go there himself.

Instead, he sketched a map of directions as well as he remembered them, and had no trouble persuading a prospector there to make the trip, for an equal interest in the property. But his new partner utterly failed to locate the mesa under the three high peaks. Other expeditions were sent out with no success, until he finally gave up and went home. No doubt his memory of various landmarks was faulty, even if he didn't realize it, but for some time he tried to get various mining engineers in the East to go in with him, for a half interest. All were highly diverted by the nuggets shown them, and a few did sign agreements of partnership, though nothing came of it. One mining man who came west to make a search for the placer is reported to have dropped a laughing comment, that all the mountains down there have the groups of three peaks, but there was no gold in any of them.

But he was wrong in such a broad statement, for there are a few operating gold mines in several of these mountains. Yet, although many others have tried to find this Lost Tub placer, it remains lost for whoever may wish to tackle it. Probably these failures are mostly due to the lack of local water, and because those who tried to find it took insufficient water to outlast a proper methodical search.

Today, however, there are desert roads which with a jeep, or some of the better cars, enable a prospector to get within at least a dozen miles of this general area. Such cars can carry water, tools, and camping outfit, for a protracted stay of many weeks and thus permit a proper examination of the entire region inside the limit mentioned. In such case, however, a word of caution is required. Spare tires are needed, also extra parts such as spark plugs, fan belt, and distributor condenser. For a break-down in the desert leaves you worse off than those old-timers travelling in a saddle. A dead car puts you afoot, you see. A helicopter would be the thing!

In any case, the mountains in this region are geologically favorable for deposits of gold or other types of commercial ore, so even if the Lost Tub placer is never found there is a fair chance of discovering another paying mine—if enough time is spent in this area.

QUIZ ANSWER

(Questions on Page 7)

In both instances you would receive pyrope, a variety of garnet. Garnets may be red, brown, black, or green. In fact, it has been maintained that garnets may have any color except blue. Pyrope is commonly red, but may be almost black. Gem-quality pyrope is commonly called "carbuncle." The garnets are orthosilicates and crystallize in the isometric system. The hardness ranges from 6.5 to 7.5. The ruby is a variety of corundum, as is the sapphire. Corundum crystallizes in the hexagonal system, forming six-sided prisms or tablets. It is the hardest of the rock-forming minerals (H 9).

BOOK REVIEW

Historical Geology

RUSSELL C. HUSSEY

McGraw Hill, $3.75

465 pp. 352 illustrations

This historical geology, properly the geologic history of North America, is the second edition of Prof. Hussey's popular text which was first published in 1944.

The author states that he has kept in mind the fact that the book will be used chiefly by students and others interested in the cultural aspect of the subject. The new edition is simplified in several places by the removal of material which students seldom are required to remember, and new and improved illustrations are used. The result is a text which provides the reader with a non-technical account of the development of life during the last two billion years of earth history. If one is led into fields of special interest, there are reading references at the end of each chapter.

Students who pursue historical geology for its cultural value too often are bewildered by the great amount of extraneous data in texts used in introductory courses. Hundreds of formation names serve only to cloud the grand picture of the development of life and the fascinating emergence of modern landscapes. "It is a bit confusing," remarked a student at one of the younger schools in the Middle West after delving into one of these advanced texts recently, "but we hope to get through the Silurian by December!"

Prof. Hussey, as his classes at the University of Michigan have been discovering through the years, holds to the moving scene and to general principles in both text and lectures. "Every stone can be dramatized," the author once remarked, and this without sacrifice of accuracy.

"It is very encouraging," Prof. Hussey states in the preface of his new volume, "to see the large number of students who are studying elementary physical and historical geology because both subjects contain a great deal of material that is both valuable and interesting. Increasing numbers of Americans are seeing more of our country every summer, and geology is one subject that will help them to understand the face of the earth with its varied features."

The illustrations, particularly the drawings by John Jesse Hayes, are excellent.

The book merits a large following.

WITH THE CLUBS

Pomona Valley Mineral Club held its monthly meeting in the chemistry building, Pomona College, and was host to the members of the Old Baldy Lapidary Society. George J. Belleman, of Los Angeles City College, gave a talk on "Alluvial Fans" and illustrated his lecture with slides of alluvial fans taken after the 1938 flood. The most perfect of these features, in his opinion, is the Deer Canyon fan in San Bernardino County, California.

Michigan Mineralogical Society held its October meeting at the Cranbrook Institute of Science, Bloomfield Hills. Andrew Meyer, Cleveland mining engineer who follows the paths of the Spanish explorers in Panama, told of his search for ancient gold mines. He is returning to the Isthmus to work these old mines with modern equipment. The annual auction is the feature of the November meeting.

At the October meeting of the Central Iowa Mineral Club, Murray Work led the discussion on agates and Frank Sadilek gave a talk on "The Sawing and Polishing of Minerals." On Sunday, Oct. 5, members met at Johnston, Iowa, and proceeded to Herrold to collect agates in the bed of the Des Moines River.

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LETTERS TO THE EDITOR

The Editor,
Earth Science Digest.
Dear Sir:

I have just read the article, "The Lost Dutchman", by Victor Shaw, in the April issue of your magazine. Mr. Shaw knows nothing of the facts regarding the most famous lost gold mine in America . . . not one of the writers over the period from 1916 to the present ever had Jacob von Walzer's name correct, his date of death correct, nor the place of his burial . . . I can personally take Mr. Shaw into the locale of the Lost Dutchman and show him rose quartz. I can show him 30 or 40 shafts and tunnels within sight of Weaver's Needle.

Charles Frederick Higham,
Phoenix, Arizona.

The Editor,
Earth Science Digest.
Dear Sir:

I do not wish to waste time discussing with my critics the Walzer personal history. But I do take issue with any and all critics concerning the local geology of the region in question, which I examined during three expeditions. Regarding seeing the Needle for 20 miles in any direction, I've seen it twice that distance from the Mazatzal Range to the north, since the canyons around the Needle all lie roughly north-and-south. What of it? It's wholly immaterial.

Victor Shaw,
Lake Hughes, Calif.

Mr. Victor Shaw,
Lake Hughes, Calif.
Dear Sir:

I myself rode and tramped over much of the Superstition Mountains 30 years ago and made detailed examinations of gold prospects near the western base. Other employes of the Arizona Bureau of Mines have done enough work in the region to satisfy them that conditions are decidedly adverse to the existence of commercially valuable deposits of gold in the Superstition Mountains. We have never hesitated to express our conviction that prospecting there is a complete waste of time.

Some 15 or 20 years ago an old miner died at Superior. He always claimed that he was very well acquainted with Jake Walz, who lived most of his time at or near Wickenburg, especially when the Vulture Mine was running. The Superior miner always claimed that Walz accumulated a rather large amount of rich Vulture ore and rode to the neighborhood of the Superstition Mountains with it and brought it from there to Phoenix, claiming or permitting it to be known that he got it in the Superstition Mountains.

G. M. Butler,
Dean, College of Engineering,
University of Arizona,
Tucson, Arizona.

To the Editor,
Earth Science Digest.
Dear Sir:

Mr. Shaw has made a good job of presenting facts concerning a legend that has probably mislead more people than most other "lost mine" stories.

John W. Mrock
Indio, Calif.

THE ORIGIN OF DOLOMITE

KENNETH J. ROGERS

Reprinted from an earlier issue of The Earth Science Digest in response to many requests.

While Marie Antoinette was shouting, "Let them eat cake," a Frenchman, T. de Dolomieu, was discovering that all that is limestone does not fizz. The region where he worked was later appropriately named the Dolomites. Were one to have asked this Frenchman to account for this non-fizzing limestone, he would have been baffled; were one to ask us to account for it we would theorize, but in the main, we are just as baffled as was he. For, where theory reigns bafflement abounds.

Today "dolomite" is used in two ways: mineralogically, as the name of a mineral, and geologically, as the name of a rock largely or wholely composed of it. The mineral dolomite is a compound of magnesium and calcium carbonates combined directly in the molecular ratio of one to one $CaCO_3 . MgCO_3$. Pure dolomite consists of 54.35% $CaCO_3$ and 45.65% $MgCO_3$.

Dolomite, it is believed, can be either a primary or a secondary product, i.e., it can be formed through direct precipitation in sea water or by the alteration of pre-existing limestones. The limestones can be altered by the sea water in which it is lying or by hot or cold waters which may percolate through it, but in both, the manner of change is essentially the same; that is, the water carries the magnesium carbonate which replaces some of the calcium carbonate of the limestones to form dolomite. In the case of percolating waters some of the calcium carbonate may be removed to make room for the incoming magnesium carbonate by leaching. And so the chemical changes may be made at the time of deposition and dolomite laid down as we now find it, or a calcareous mass may be laid down first and then later changed to dolomite.

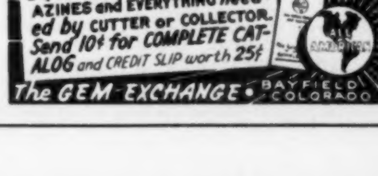
Most geologists agree that the majority of our dolomite deposits have been formed epigenetically. The theory involved is relatively simple. Picture, if you will, the numerous rivers which have from time immemorial emptied their cargoes into yawning receptive seas that have prevailed helter-skelter upon our earth's surface. Magnesium salts, all alkali carbonates, and an abundance of calcium hydrogen carbonate are assuredly a part of that cargo. They are carried far and wide by marine currents. In the seas a profusion of organisms dwell that can and do convert the soluble calcium bicarbonate into the insoluble calcium carbonate, and thereby, produce hard parts which either protect or support their soft parts. Upon their death they give up their skeletal part to the media in which they lived. A natural decree. Thousands upon thousands of such calcium carbonated parts are dropped and accumulated. To this may be added the lime from various lime-secreting algae.

To this batter of freshly laid calcareous sediments, a cup of magnesium carbonate is added to form dolomite. However, whereas organisms are largely responsible for the precipitation of calcium carbonate, the physical and chemical conditions which lead to the precipitation of magnesium carbonate are not known; likewise, the utilization of magnesium by organisms is unknown. At any rate magnesium carbonate does precipitate and falls to the sea floor where the lime is already lying. Then it is postulated some of the calcium carbonate is taken into solution and replaced by a chemically equivalent quantity of magnesium carbonate, or that the two carbonates lying promiscuously together are, upon crystallization of the sediments, converted to the double salt. An ideal assumption would be: $2\ CaCO^3 + MgCO^3 = Ca\ Mg\ (CO^3)^2 + CaCO^3$ in solution.

The primary theory is even simpler than the epigenetic one. The same story as has been depicted above can again be envisaged, only it need not go so far. The soluble carbonates supplied by the rivers unite with the magnesium element of the sea and form dolomite. Given such reagents, soluble double carbonate and sea water rich in magnesium, the exchange of elements is fundamental, the resultant product being dolomite which as an insoluble passes by way of precipitation from the field of action according to the laws of chemistry. However, notwithstanding the plausibility of the action, the theory of the thing becomes apparent when we learn contrary to expectations that examinations of present sea floors have revealed very little dolomite.

We can with justification say that the preponderance of our dolomite originated in warmer climes, for in warm water a sharp increase of denitrifying bacteria is noticeable; and these organisms by their physiological processes are responsible for the throwing down of huge quantities of lime carbonate. Then too, tropical rivers carry magnesium and calcium salts to the oceans at a faster rate than elsewhere. The core and samples from a well drilled on Funafuti Atoll shows that magnesium carbonate decreases at depth. This would seem to prove that dolomite originated in shallow water, but certainly does not prove that shallow water is requisite for the birth of dolomite. That dolomites were universally formed under reducing conditions seems likely inasmuch as ferrous iron is present in a surprisingly large number of the dolomites. The iron percentages runs anywhere from 10% to less than 1%. Since ferrous iron is readily oxidized, its presence negatives the view that dolomites developed through replacement by ground water. The big three involved in producing dolomite, i. e., time, temperature, and pressure are, as usual in the fashioning of Nature's wares, mysteries. Laboratory estimates have been made based on attempts to simulate nature's environmental conditions, but much more has yet to be done before the origin of dolomite can pass from the realm of theory.

The fact as to how magnesium got into dolomite may be somewhat of a puzzle to all peoples, but that it is there the English can well testify. When the order was given to build the houses of Parliment, dolomite was chosen as the building stone, and the buildings subsequently became, because of the sulphurous fumes, of nearby potteries, corroded with a layer of epsom salts affording to the people who would but scrape the walls, a free purgative.



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(From Page 14)

fluorescing materials alone, under two Stroblites, the second was of two youngsters bending over the minerals, lighted by spot lights. Colored gelatin can be used on the spot lights to produce varied color effects, as the photographer desires.

Viles used a special filter system and then made a two-second exposure at aperture F 11.